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ORIGINAL ARTICLE

Diagnostic Accuracy of IVU Compared to Unenhanced CT KUB for Detection of Urinary Tract Calculi

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ABSTRACT

Objective: To compare the diagnostic Accuracy of IVU to unenhanced CT KUB for detection of urinary tract calculi.

Patients and Methods: This cross-sectional study was carried out at department of Radiology, Aziz Fatimah Hospital Faisalabad, from October 2016 to July 2017. All the patients having suspected Urolithiasis or ureteric colic indicating urolithiasis and referred to the Radiology department for IVU or CT KUB were selected in study sample. All the patients were briefly described about the study and informed written consent was obtained. A sample of 83 suspected patients of urolithiasis were included in the study sample. All patients in study sample who were referred for CT KUB or IVU were offered the other test free of cost. All the information including demographics, IVU and CT KUB were recorded on a predesigned performa. The data was entered and analyzed on SPSS version 21.

Results: There were 48 (57.83%) males and 35 (42.17%) female patients. The mean age of the patients was 46.58 ± 9.42 years, ranging from 25 to 60 years. The final diagnosis showed that there were 59 (71.10%) positive patients for renal or ureteric stone. On the basis of IVU screening test 45 (54.21%) patients were positive, 38 (45.78%) were negative and 21.69% (16/83) patients had inconclusive results. CT KUB diagnosed 58 (69.87%) positive and 25 (30.12%) negative patients. The diagnostic parameters of IVU were considerably poor as compared with the CT KUB having sensitivity (72.08%), specificity (91.67%), PPV (95.56%), NPV (57.89%) and accuracy of 78.31%. The sensitivity, specificity, PPV, NPV and accuracy of 96.61%, 95.83%, 98.28%, 92.00% and 96.39% respectively.

Conclusion: CT KUB provides more efficient information about the patients, presenting with acute renal colic. It has significantly higher rate of diagnosing urolithiasis in comparison of IVU.

Key words: CT KUB, Diagnostic accuracy, IVU, Renal colic, Urolithiasis.

Author`s Contribution
[1] Conception, synthesis, planning of research and manuscript writing
[2,3] Interpretation and discussion Data analysis, Interpretation, manuscript writing and Active participation in data collection

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Article info.
Received: October 6, 2017
Accepted: November 7, 2017

Cite this article. *Imran F, Zaman Z, Iqbal M.J. Diagnostic Accuracy of IVU Compared to Unenhanced CT KUB Detection of Urinary Tract Calculi. JIMDC.2017;6(4):*

Funding Source: *Nil*
Conflict of Interest: *Nil*

Introduction

Renal and Ureteric stone disease is very prevalent globally and affects a large population throughout the world. It is equally prevalent among all races and cultures. There is no variation in its occurrence with respect to geographic areas of the world. Its incidence is increasing both in developed and developing countries from last few decades. The foremost cause for this increasing trend is considered as obesity due to life style changes and sedentary living habits.[1] Acute loin pain due to renal or ureteric stone is a common diagnosis in the accident and emergency department. A stone in the kidney alone does not warrant emergency management apart from superimposed infection, but a stone impacted within the ureter requires prompt diagnosis, urological referral and

urgent intervention in specific circumstances. The classical clinical symptoms of ureteric colic, such as loin pain that radiates to the groin, vomiting and microscopic hematuria, frequently overlap with other clinical presentations such as pyelonephritis, appendicitis, gynecological problems or diverticulitis. Therefore, imaging plays an important role in obtaining an accurate diagnosis with this clinical presentation so that the patient can be promptly triaged into the correct clinical management pathway.[2, 3]

Urolithiasis is not life threatening condition but it can cause very severe complications including chronic renal disease and infections so its proper management is essential for better prognosis of the patients. The recurrence rate of urolithiasis is also quite high which makes its proper management more crucial. The initial diagnosis, planning of the treatment and efficacy of the treatment of urolithiasis is mainly dependent upon imaging studies of urolithiasis.[4] There are many imaging modalities, which are commonly used for study of urolithiasis, and with time, these modalities are improving in identification of ureteric stones. For the radiological study of ureter, bladder and intra renal collecting system, intravenous urography (IVU) has been used as modality of choice for a long time. It has quite high sensitivity (66-87%) and specificity (92-94%) in diagnosing ureteric stones.[2,5] In patients with raised level of serum creatinine, contrast material cannot be used so in such patients imaging modalities are required, which can effectively diagnose ureteric diseases without use of contrast materials. The imaging modalities, which can be used, include combination of plain abdominal radiography (KUB) and gray scale ultrasound (US) kidney, ureter and bladder.[6, 7] Another imaging modality which has got a lot of attention these days is unenhanced CT (CT KUB). It is used mainly for assessment of suspected renal colic but now it has become primary screening tool for diagnosis of urolithiasis with a high sensitivity and specificity. This test is being prescribed by all specialists along with urologists. A disadvantage of CT KUB is its greater exposure to radiations. Previous studies have shown very high sensitivity (> 95%) and specificity (96%) for diagnosis of ureteric stones. This technique has many other advantages of faster speed of acquisition without any administration of intravenous contrast and easy availability. The multi-detector CT has further enhanced the management of urolithiasis.[8, 9]

Non-enhanced CT (NECT) is equal to the IVU in diagnosing the obstruction and more reliable in diagnosing nephrolithiasis. An added advantage of CT over IVU is its ability to diagnose other causes of flank pain, such as appendicitis or acute gynecological conditions. Radiation dose is currently one of the major disadvantages of CT.[10]

When CT is available, it is the study of choice in the non-pregnant adult presenting with flank pain. IVU is still the best investigation if NECT is not available.

Patients and Methods

This cross sectional validation study was carried out at department of Radiology, Aziz Fatimah Hospital Faisalabad, from October 2016 to July 2017. All the patients having suspected Urolithiasis or ureteric colic indicating urolithiasis and referred to the Radiology department for IVU or CT KUB were selected in study sample. All the patients were briefly described about the study and informed written consent was obtained.

After taking ethical approval from the institutional ethics committee a sample of 83 suspected patients of urolithiasis were included in the study sample. The sample size was calculated by WHO sample size calculator with sensitivity (93.6%) and specificity (95.6%), expected prevalence of 40% and with required precision level of 7% and confidence level of 95%. Patients of both genders and age range of 25 to 60 years were included in the study. Patients, who presented with history of urolithiasis in last 6 months, or patients having positive finding on any imaging modality for urological problems and patients having renal disease were excluded from the study. Patients who were pregnant or who had renal function impairment or previous allergic reaction to contrast medium were also excluded from this study. All patients in study sample who were referred for CT KUB or IVU were offered the other test free of cost.

The Non-enhanced CT (NECT) were obtained on a 16 slice helical CT scanner (TOSIHBA Alexion). All scans were obtained from the upper border of T12 vertebral body to the lower border of symphysis pubis, without the use of oral or intravenous contrast material. Patients were placed in supine position with full urinary bladder at the

time of the non-enhanced CT (NECT). Additional prone films were taken whenever the radiologist needed a better description of suspected distal ureteric calculi. The CT report was reviewed by consultant radiologist on workstation (with 1mm reconstructed images in coronal, sagital and axial planes) for the diagnosis of a stone in the urinary tract or secondary cause of obstruction.

For IVU, a plain abdominal film was taken at the beginning of the examination. After intravenous administration of non-ionic contrast medium (contrast calculated according to weight of the body), 5 minutes' anteroposterior view, 15 minutes anteroposterior and bilateral oblique views, 30 minutes' anteroposterior view and post voiding view were taken. Further delayed images were taken if necessary. The final diagnosis was confirmed according to the endoscopic evaluation, operative findings, pathology report and follow-up course for at least 3 months.

All the information including demographics like name, age, gender, results of IVU and CT KUB were recorded on a predesigned Performa. The data was entered and analyzed with SPSS v 21. A 2x2 cross table was used to calculate sensitivity, specificity, positive predictive value and negative predictive values.

Results

In this Cross sectional validation study a total of 83 suspected patient of urolithiasis were included, among them 48 (57.83%) were males and 35 (42.17%) were female patients. The mean age of the patients was 46.58 ± 9.42 SD years, ranging from 25 to 60 years. Most of the patients 37 (44.58%) were of age > 45 years followed by 29 (34.94%) patients in the age interval of 35-45 years. Seventeen (20.48%) patients were in the age interval 25-35 years. (Table 1). The final diagnosis was confirmed according to the endoscopic evaluation, operative findings, pathology report and follow-up course for at least 3 months. The final diagnosis showed that 59 (71.10%) patients were diagnosed as positive for renal or ureteric stone and 24 (28.91%) patients were negative for urolithiasis. Among these patients, two had concomitant renal cell carcinoma and one had transitional cell carcinoma. Among the patients who were negative for ureteric stone, 15 (62.50%) had no certain urologic abnormality. Six (25%) patients were confirmed with acute pyelonephritis and 3 (12.5%) pelvic mass.

Table 1: Demographic Characteristics of the patients

Characteristics	Frequency	Percentage
Gender of the patients		
Male	48	57.83
Female	35	42.17
Age of the patients	25 - 60 years	
Mean ± SD	46.58 ± 9.42	
Range		
25-35	17	20.48
35-45	29	34.94
> 45	37	44.58

The results of the diagnostic tests showed that 45 (54.21%) patients were positive and 38 (45.78%) were negative for urolithiasis on the basis of IVU screening test, having a rate of true positive as 43 (72.88%) and true negative as 22 (91.67%). (Table 2).

Table 2: Diagnostic Results of the IVU and CT KUB

	Final Diagnosis		
	Positive	**Negative**	**Total**
Final result on IVU			
Positive	43	2	45
Negative	16	22	38
Final results on CT KUB			
Positive	57	1	58
Negative	2	23	25
Total	59	24	83

Based on IVU study 21.69% (16/83) patients had inconclusive results on the basis of IVU and further required other imaging investigations. In patients of pyelonephritis there were no significant findings on IVU study, but CT images showed clear unilateral renal enlargement with fat stranding adjacent to peri and pararenal areas as classic inflammatory changes. The results on the basis of CT KUB showed that there were 58

(69.87%) positive and 25 (30.12%) negative patients for urolithiasis in the study. The rate of true positive and true negative cases in CT KUB were noted as 57 (96.61%) and 23 (95.83%) respectively as elaborated in table 2.

According to the results of the study, the diagnostic parameters of IVU were considerably poor as compared with the CT KUB having sensitivity (72.08%), specificity (91.67%), positive predictive value (95.56%) and negative predictive value of (57.89%). The accuracy of IVU for detection of urolithiasis is 78.31%. The sensitivity, specificity, positive predictive value and negative predictive value of CT KUB for detection of urolithiasis is 96.61%, 95.83%, 98.28% and 92.00% respectively. According to the results, the accuracy of CT KUB for diagnosis of urolithiasis was found to be 96.39% as given in table 3.

Table 3: Diagnostic Accuracy of IVU and CT KUB

Diagnostic Parameters	IVU	CT KUB
Sensitivity	72.08%	96.61%
Specificity	91.67%	95.83%
Positive Predictive Value	95.56%	98.28%
Negative Predictive Value	57.89%	92.00%
Accuracy	78.31%	96.39%

Discussion

There is some limitation of normal abdominal radiography (Kidney, ureter and bladder (KUB) alone, when it is used for diagnosis of urolithiasis. The factors which can confound the results include bowel gas, large physical stature of the patient and extra renal calcification. Factors like these have a very poor effect on sensitivity of KUB radiography for diagnosis of renal or ureteric stones. Although ultrasound is cost effective and easily available modality but it has reduced accuracy for detection of suspected renal stones. This diagnostic accuracy does not have any added advantage of experienced radiologist for diagnosis of ureteric calculi.[11] Some advanced imaging modalities like unenhanced helical CT has become very popular and acceptable for diagnosis of suspected ureteric stones. It has become primary investigation technique for evaluation of urinary tract calculi. The reason of its popularity is because of very high sensitivity which ranges from 95%–98% and specificity ranging from 96%–100%.[12]

Additional advantages of CT over other imaging techniques is that it does not require contrast medium; it can be performed very rapidly. The CT has the ability of diagnosing small size stones along with large ones. The CT also has the capacity to identify the urinary and extra urinary abnormalities.[13,14] Recent studies have found increasing prevalence of urolithiasis worldwide. Past literature shows that urolithiasis was most common in male patients as compared to females. However, this trend is changing and the incidence of urolithiasis is increasing considerably in female patients. This rising incidence of urinary stone is alarming because it has direct effect on cost involved, morbidity including complication like chronic renal failure and risk of infections in the patient.[15] In this present study the proportion of female patients has been observed quite high (57.83% vs 42.17%) as compared to previous some studies who have noted a considerably lower rate of female patients as compared to males like in study of Chaudhry et al, in which the ratio of female patients was very low (27.5% vs. 57.5%) as compared to male patients.[16] Similar results were found in a study of Nadeem M et al, who found 30% females and 70% male patients.[17]

Literature shows that it has significantly higher prevalence in males as compared to females. The common age interval of its occurrence is 30 to 60 years.[18] In this study the mean age of the patients was 46.58 ± 9.42 years, ranging from 25 to 60 years. In patients of urolithiasis the diagnosis, management and follow up, all is dependent on imaging. The use of different imaging modalities has a long history; many techniques have been in practice for diagnosis of urolithiasis. The commonly used imaging modalities by urologist include plain radiography of kidneys, ureter and bladder (KUB), IVU, ultrasound (US), magnetic resonance urography (MRU) and computed tomography (CT), each with its advantages and limitations. IVU has been accepted as a gold standard technique for a long time in diagnosis of ureteric stones. Recently, new imaging modalities like non-enhanced computed tomography is getting more reputation as a

diagnostic tool for urolithiasis. The reason being its ease in performing the test and high sensitivity and specificity.[19] In patients diagnosed with urolithiasis, the proper treatment and follow up is essential, which is possible through imaging. The imaging techniques used for follow up are postoperative X-Ray KUB or IVU for the assessment of outcomes after treatment and recurrence. These imaging modalities are not very sensitive for identification of small stones or residuals fragments. Non-enhanced CT is considered as more sensitive for proper detection of residual fragment and better decision making for prognosis of the patient. When KUB and US are used alone for follow up of ureteroscopy, according to a recent study the results of diagnosis for urolithiasis can be overestimated with KUB and US alone.[20]

According to the previous studies, CT KUB has many advantages over IVU. Especially for ureteric stones, it is the most preferred modality these days. It also has higher diagnostic accuracy over other imaging modalities. It has sensitivity and specificity of 96-100% respectively.[17] Another advantage of CT over IVU is its proficiency of identifying renal colic with alternate causes of flank pain. According to the results of this present study, IVU showed a sensitivity (72.08%), specificity (91.67%), positive predictive value (95.56%) and negative predictive value of (57.89%). The accuracy of IVU for detection of urolithiasis was 78.31%. The sensitivity, specificity, positive predictive value and negative predictive value of CT KUB for detection of urolithiasis was noted to be 96.61%, 95.83%, 98.28% and 92.00% respectively. According to the results, the accuracy of CT KUB for diagnosis of urolithiasis was found to be 96.39%. The results are in agreement with previous findings of different studies like studies of Nadeem M, Ather MH and Rekant MN who found similar sensitivity parameters of CT KUB.[17, 21, 22]

A study by Amin Z et al, revealed a very high sensitivity and specificity of IVU in contrast to this present study. He found the sensitivity of IVU as 93.6%, specificity of 95.6 %, negative predictive value of 91.6%, and positive predictive value of 96.8% with an accuracy of 94.5%,[23] which is quite higher than the results of this present study. Due to many advantages non-contrast enhanced CT is becoming preferred imaging modality of physicians in emergency response departments. It is favored because in busy emergency response it has the ability to rapidly triage the patient. However, this hastily prescription of CT test is increasing the rate of negative CT. In this present study, the efficacy of IVU was compared with CT KUB for diagnosis of urolithiasis and it was observed that efficacy of CT was extremely high in contrast to IVU and the finding of CT study identified more stones of small size as well. Some of which did not require vigorous interference at the time of diagnosis but required active surveillance. These incidental findings of CT also make it better than IVU. One major advantage of IVU is the evaluation of delayed excretion, which cannot be evaluated by non-contrast enhanced CT.

Conclusion

The results of this study reveal that unenhanced CT KUB has more accuracy as compared with IVU for diagnosis of urolithiasis in suspected patients. It provides more efficient information about the patients presenting with acute renal colic. CT KUB has significantly higher rate of diagnosing urolithiasis in comparison of IVU. The CT also reduces the risk of adverse reactions of nephrotoxicity caused by the administration of contrast agents. So the use of IVU could be replaced by CT KUB as diagnostic tool for urinary tract calculi.

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